

CLOSING THE SKILLS GAP

The Data Behind Talent Shortages,
High-Skilled Immigration, and
Economic Impact



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I. Methodology & Executive Summary

This report fundamentally aims to define and contextualize the state and intersection of skilled immigration and the American technology economy, especially as it pertains to skill shortages. These talent deficits, colloquially known as the “skills gap,” were quantified in this analysis as the number of unfilled or vacant jobs and qualified as the expressed difficulty of firms to fill positions requiring prior experience, skill, or training. In adherence to these definitions, it is estimated that, in the next decade, the nation could face a shortage of about 765,000 needed workers with the skills that come from an Associate’s degree or some college; that figure is raised to 8.62 million for needed workers with a Bachelor’s degree or higher.¹ Combined, about 5.6 percent of the estimated 2029 labor force will require a post-secondary degree. These vacancies are characterized by misalignment between the skills supplied by the workforce and those demanded by employers, especially STEM firms. A recent study found that the U.S. faces about a \$1.2 trillion loss in economic output by year 2029 if shortages of workers with a post-secondary degree persist.

Given this, research proceeded with a twofold approach: first providing background on the condition of the U.S. economy centered around the fields of science, technology, engineering, and mathematics (STEM) in aggregate, and separately for each of the 50 states. In both cases, analysis was conducted using current production figures as well as growth and employment projections provided by CompTIA’s annual Cyberstates report (the report covering 2020 was used to optimize recency) on the state of tech employment and output. This allowed for the ranking of, and comparison between, states regarding tech output, employment, and predicted STEM expansion. Because the source was used to contrast rather than describe states, any macroeconomic fluctuations wrought by the COVID-19 pandemic were negligible. Even so, to accommodate any error in using recession year data, the data sources also quantified the state of the tech economy in 2019, a year of secure economic growth.

In addition, survey and employment data available through the United States Bureau of Labor Statistics (BLS), as well as data on educational attainment by discipline available through the National Center for Education Statistics (NCES), provided figures on the number of tech employees in the economy at large as well as each state’s quantity of awarded tech degrees. In the latter case, the supply of “skill” was operationalized as the number of computer science

¹Douglas Holt-Eakin and Tom Lee, “Projecting Future Skills Shortages Through 2029,” American Action Forum, July 18, 2019, https://www.americanactionforum.org/research/projecting-future-skill-shortages-through-2029/?utm_source=American+Action+Forum.

degrees awarded in each state, as the majority of skill shortages exist in the professions of software development and programming.

Upon analyzing these variables, it was concluded that a significant misalignment exists between the availability of skilled labor and demand within the American workforce.² Moreover, although the United States tech economy has expanded and will likely continue to do so, the existence of widening misalignments has suppressed growth below optimal levels. The verified existence of the “skills gap” served as the impetus for further research on potential solutions to the talent shortage.

When seeking to rectify supply and demand discrepancies with respect to the high-skilled workforce, most solutions either relate to investment in American human capital (through enhanced education and investments in workforce development) or to increased immigration, particularly high-skilled immigration. As examined later in this paper, investments in American human capital would require a focused national strategy, could take years to yield results, and ultimately would not address the immediate high-skills shortage. Therefore, the intersection of skilled immigration and the tech sector was examined.

To do so, data and consolidated statistics on the demographic, educational, and income attainments of H-1B and other temporary and permanent worker visa holders were pooled from the United States Customs and Immigration Service (USCIS), as were admission statistics and demographic data on skilled workers made available through non-governmental institutions like the Pew Research Center and the American Immigration Council. Both sources, among numerous others, quantified the national and state-by-state foreign-born and H-1B-holding STEM workers.

It was found that immigrants make up a disproportionately large cross-section of the STEM workforce (or, foreign-born workers are a larger percentage of the STEM workforce than they are of the population) both nationally and regionally, indicating a heavy reliance on foreign-born labor to accommodate the demand for technology and technology workers. Among these high-tech firms, it was found that a majority of those whose staffs were more than 50 percent H-1B workers compensated their skilled workers less than similar firms that were not dependent on H-1B visa holders.³ That being said, the vast majority of H-1B visa recipients are advanced degree holders who, in all states and nationally, earn upwards of \$20,000 to \$40,000 more than the average American.⁴ Thus, contrary to the beliefs of some, high-skilled immigrants

² Robert Palmer, “What Is Skills Mismatch and Why Should We Care?,” International Labour Organization, April 1, 2020, https://www.ilo.org/skills/Whatsnew/WCMS_740388/lang-en/index.htm.

³ Deborah D'Souza. “The H-1B Visa Issue Explained.” Investopedia. August 28, 2020, <https://www.investopedia.com/news/h1b-visa-issue-explained-msft-goog/>.

⁴ Jessica Semega et al., “Income and Poverty in the United States: 2019,” U.S. Census Bureau, September 15, 2020, <https://www.census.gov/library/publications/2020/demo/p60-270.html>.

do not appear to be taking the jobs of Americans by accepting lower salaries or wages, generally. In fact, a number of studies expounded upon throughout the report reach opposite conclusions: immigration *boosts* employment and earnings for *American* employees.⁵ Given the rising demand for high-skilled work, it seems that firms prioritize hiring and sufficiently compensating high-skilled workers regardless of their country of origin.

In addition to examining the direct implications of temporary and permanent worker visas for technology, research was conducted to identify skilled immigration's effects on other sectors of the economy through a thorough review of existing research. It showed that skilled immigration bears numerous positive externalities in other economic sectors and may indeed have the capacity to "fill" the tech sector's talent misalignment. After an analysis of the state-by-state prevalence of immigrant entrepreneurs and jobs generated from skilled immigration in academics and the workforce, it was concluded that high-skilled immigration, in nearly every state, also results in overall job and economic growth, productivity, innovation, and collaborative workforce culture, with far-reaching benefits for the healthcare and finance spheres.

The evidence also suggests that such benefits are long-term. A 2015 study found that high-skilled STEM and technology workers were responsible for up to 50 percent of long-run U.S. productivity growth.⁶ With approximately a third of workers in the IT and tech field being foreign-born, it can be anticipated that increasing the number of high-skilled immigrants in STEM and tech would continue the STEM/tech-driven productivity and economic growth throughout the U.S.⁷ Insofar as the American tech economy faces an ongoing skill misalignment whose negative ramifications can be combated by the aftereffects of skilled immigration, the extension of temporary and permanent work visas may serve as an antidote to the skills gap, accelerate nationwide technology growth, and bolster the already large economic contributions of American immigrants.

II. The American Immigration System | A Brief Overview

The American immigration system is aimed at achieving several objectives, including uniting families, incorporating skilled immigrants into the U.S. economy, refugee outreach, and

⁵ Giovanni Peri, Kevin Shih, and Chad Sparber, "STEM Workers, H-1B Visas, and Productivity in US Cities," *Journal of Labor Economics* 33, no. 3, pt. 2 (2015): 225-255, <http://www.jstor.org/stable/10.1086/679061?origin=JSTOR-pdf>.

⁶ Peri et al., "STEM Workers, H-1B Visas, and Productivity in US Cities." <https://doi.org/10.1086/679061>

⁷ Adrian Otoi, "Trends among Native- and Foreign-Origin Workers in U.S. Computer Industries: Monthly Labor Review," U.S. Bureau of Labor Statistics, December 1, 2017, <https://www.bls.gov/opub/mlr/2017/article/trends-among-native-and-foreign-origin-workers-in-us-computer-industries.htm>.

diversity augmentation.⁸ While these aspirations are decades in the making, immigration law has been subject to both progress and regress in the past century.

At the start of the twentieth century, the expansion of the American labor force was largely due to increased immigration, with foreign-born workers comprising nearly 21 percent of the workforce in 1915. While restrictions placed in the 1920s through the *Emergency Quota Law* and *Immigration Act of 1924*, collectively referred to as the “quota acts,” slowed this trend, employment-based immigration steadily surged starting in 1965 upon the passage of reformative amendments to the *Immigration and Nationality Act* (INA). By 2005, the immigrant labor force participation had nearly returned to early pre-*Quota Act* levels.⁹

Under the current iteration of the INA, the United States permits the admission of 675,000 permanent foreign residents each year, with no cap on the number of U.S. citizens’ immediate family members admitted. These admittees span a number of preferential classifications, the two most superordinate of which are family-based and employment-based immigration. For non-immediate family-based immigration, the number of immediate family members admitted is subtracted from the automatically extended family allocation of 480,000. Unused employment-preferential slots from the previous year roll over to the current year and are added to the remaining extended family slots.

Additionally, the INA sets a floor of 226,000 extended family-based visas that may be distributed. Coupled with the often over 250,000 immediate family members admitted, the number of available slots for family-based visas (both immediate and extended) is often greater than the default 480,000.¹⁰ Despite this, the number of family-sponsored immigrants has declined every year since 2017.¹¹

Regarding employment-based immigration, two primary preferential categories exist: temporary visas and permanent immigration. In the former, firms can request to grant entry to foreign workers interested in specific jobs, typically on a short-term basis. This category of employment-motivated immigration, technically classified as “non-immigration” because the baseline for migrants is temporary rather than permanent residence, has 35 subcategories, including the one that is most associated with high-skilled immigration: H-1B visas. Many of these

⁸ “How the United States Immigration System Works,” American Immigration Council, October 10, 2019, <https://www.americanimmigrationcouncil.org/research/how-united-states-immigration-system-works>.

⁹ Claudia Goldin and Lawrence F. Katz, “Long-Run Changes in the Wage Structure: Narrowing, Widening, Polarizing,” *Brookings Papers on Economic Activity*, no. 2 (2007): 135-65. https://www.brookings.edu/wp-content/uploads/2007/09/2007b_bpea_goldin.pdf.

¹⁰ “How the United States Immigration System Works,” American Immigration Council.

¹¹ Ryan Baugh, “U.S. Lawful Permanent Residents: 2019,” Office of Immigration Statistics, U.S. Department of Homeland Security, September 2020, https://www.dhs.gov/sites/default/files/publications/immigration-statistics/yearbook/2019/lawful_permanent_residents_2019.pdf.

subcategories allow the worker to apply for legal permanent resident status, meaning that they do not currently have but are eligible to seek immigrant status.¹²

Permanent residency for foreign workers, or long-term employment-based immigrants, is capped at 140,000 per year, which includes both eligible immigrant workers and their immediate family members. This means that the true number of employees is actually much less than 140,000. The truncated number of employee immigrants are from one of five categories: those of “extraordinary ability,” such as professors, researchers, and executives; advanced degree holders; skilled workers with higher education experience; “special immigrants” including clergy people, foreign service workers, or U.S. government employees; and individuals making \$500,000 - \$1,000,000 investments in American job creation.¹³ While the number of such immigrants has increased in recent years, it is insufficient to address the 1.1 million job discrepancy between unfilled jobs and Americans looking for work.¹⁴ Indeed, in 2014, 39 percent of 38,000 American employers “reported difficulty filling positions due to lack of available talent.”¹⁵ Moreover, in 2017, it was found that 60 percent of American firms experience job vacancies that last longer than 12 weeks, incurring an average of more than \$800,000 in losses per firm each year.¹⁶

¹² “Directory of Visa Categories,” U.S. Department of State, Bureau of Consular Affairs, 2021, <https://travel.state.gov/content/travel/en/us-visas/visa-information-resources/all-visa-categories.html>.

¹³ “How the United States Immigration System Works,” American Immigration Council.

¹⁴ “Nonimmigrant Admissions by Selected Classes of Admission and Sex and Age,” U.S. Department of Homeland Security, March 16, 2021, <https://www.dhs.gov/immigration-statistics/readingroom/NI/NonimmigrantCOAsexage>; and Jeff Cox, “There are about 1 million more job openings than people looking for work,” CNBC, August 2021, <https://www.cnbc.com/2021/08/07/there-are-about-1-million-more-job-openings-than-people-looking-for-work.html>.

¹⁵ James Bessen, “Employers Aren’t Just Whining – the ‘Skills Gap’ Is Real,” Harvard Business Review, August 25, 2014, <https://hbr.org/2014/08/employers-arent-just-whining-the-skills-gap-is-real>.

¹⁶ “The Skills Gap is Costing Companies Nearly \$1 Million Annually, According to New CareerBuilder Survey,” CareerBuilder LLC, April 13, 2017, <https://press.careerbuilder.com/2017-04-13-The-Skills-Gap-is-Costing-Companies-Nearly-1-Million-Annually-According-to-New-CareerBuilder-Survey>.

III. Immigration's Economic Implications

A. *Assuaging Concerns*

The extent of the skills gap implicates an incentive for maximizing skilled immigration, which existing research suggests would reap several positive impacts. The most recent economic literature suggests that the presence of immigrants in the workforce simultaneously increases American incomes, overall wages, the availability of opportunities, and U.S. employment.

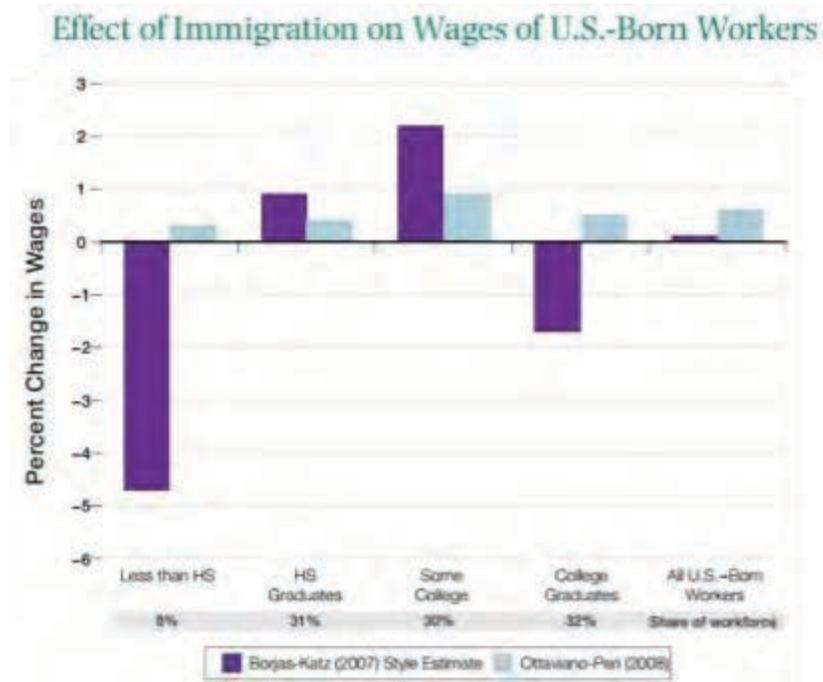
Despite the aggregate advantages, though, the literature is divided regarding disproportionate wage impacts of immigration on particular groups of U.S.-born workers. Specifically, the wages of low-skilled and college graduate native-born workers have dropped according to some estimates, although other models have suggested an increase in wages for the same workers.¹⁷ This conflict is displayed below in **Figure I**, which visualizes estimates of the wage impacts of immigration using two different methodologies from two different independent studies.¹⁸

Even if the most pessimistic estimates are true, however, overall wage increases for all U.S.-born workers, coupled with significant improvements in salaries for high school graduates and those with some college experience as shown in **Figure I**, have been positively impacted by immigration. Such benefits are amplified in the context of high-skilled immigration, as demonstrated below.

¹⁷ Michael Greenstone and Adam Looney. "What Immigration Means For U.S. Employment and Wages." Brookings, May 4, 2012, <https://www.brookings.edu/blog/jobs/2012/05/04/what-immigration-means-for-u-s-employment-and-wages/>.

¹⁸ "Impact of Immigration on Wages of U.S. Born Workers." The Hamilton Project. September 28, 2010, https://www.hamiltonproject.org/charts/impact_of_immigration_on_wages_of_u.s._born_workers.

Figure I



Note: Ottaviano and Peri (2008), Table 7; March 2008-2009 CPS, U.S. Born Ages 25-64, numbers may not sum to 100 due to rounding

From 1990 to 2010, high-skilled immigration rose markedly by 4.8 percent, exerting its greatest impact on U.S.-born workers in STEM fields, as most high-skilled immigrant labor is allocated to the STEM sector. In theory, the increase in skilled STEM immigrants who have comparative advantages in quantitative and analytical work will move native-born employees with similar skills to reposition themselves in more advantageous parts of the industry, such as interactive and communicative areas. Under such conditions, the inflow of immigrants results in an overall outward shift in the American production function, improving the U.S.' productivity while having a marginal impact, if any, on native-born workers in similar professions.¹⁹

Even this assumption, however, does not take into consideration that there is a shortage of skilled workers. Given this scarcity, it would be unprofitable for firms to displace native-born workers when employing immigrants without exacerbating the shortage unless they intend to employ workers beyond the quantified skills gap, which would be impossible with current or evenly-raised skilled immigration caps.

Harkening back to the pessimistic estimates visualized in **Figure I**, some scholars argue that immigration negatively impacts native-born workers working in the least-skilled positions, who are generally those without high school diplomas or in the bottom 20 percent of the income

¹⁹Jie Ma, "High Skilled Immigration and the Market for Skilled Labor: The Role of Occupational Choice," *Labour Economics* 63 (2020), <https://doi.org/10.1016/j.labeco.2019.101791>.

distribution. Given that wages for low-skilled workers have dropped since 1980, it was posited that much of this wage decline could be explained by increased immigrant competition in low-skilled positions. While it is true that immigrant labor force participation is highest in low-skilled positions — immigrants comprise some 28 percent of workers who do not have a high school degree — evaluations of reduced wages due to immigrant competition are largely inconclusive and based on “unstable” results. Indeed, wage differences between high school graduates and non-graduates have remained constant for decades, independent of immigration, and what differential has arisen cannot be sufficiently explained by immigration inflows.²⁰

Many studies have used the correlation between the percentage of immigrants in a city and the employment and wages of the native population to estimate the effect of immigration. Most findings point to a small level of competition, which should be taken into account. For example, the inflow of immigrants between 1970 to 1980 generated about one to two percent increases in the labor supply of many cities. As a result, there was a similar increase in the supply of labor for low-skilled industries, with many of these immigrants competing for low-skilled jobs. During the same period, there was moderate displacement of native-born workers from industries with lower wages. Additionally, the level of displacement varies by racial and sex group. The highest displacement was native-born, black females while the lowest was black males. That being said, those same studies ultimately found, “little evidence that inflows of immigrants are associated with large or systematic effects on the employment or unemployment rates of less-skilled natives.”²¹

Studies also indicate that immigration’s negative outcomes for native-born workers are vastly outnumbered by more recent studies that yield different results. The disadvantageous effects found for native-born workers may be in part due to the type of model used to analyze the study data. For example, partial equilibrium models that use a constant-returns-to-scale production function to integrate different types of labor and capital will indicate that when labor supply, in this case, immigrant labor, increases in a particular area, a comparable decrease in wages for the native workforce will follow.²² Such models may be impracticable and will likely not

²⁰ George J. Borjas, Richard B. Freeman, and Lawrence F. Katz, “Searching for the Effect of Immigration on the Labor Market,” *Globalization and the U.S. Labor Market* 86, no. 2 (1996), https://scholar.harvard.edu/files/lkatz/files/bfk_aea_1996.pdf.

²¹ Joseph G. Altonji, David Card, “The Effects of Immigration on the Labor Market Outcomes of Less-skilled Natives,” in *Immigration, Trade, and the Labor Market*, eds. John M. Abowd and Richard B. Freeman, (University of Chicago Press, 1991), <https://www.nber.org/books-and-chapters/immigration-trade-and-labor-market/effects-immigration-labor-market-outcomes-less-skilled-natives>

²² Christian Dustmann, Uta Schönberg, and Jan Stuhler, “The Impact of Immigration: Why Do Studies Reach Such Different Results?” *Journal of Economic Perspectives* 30, no.4 (2016): 31-56, <https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.30.4.31>.

be replicated in real life. Indeed, most recent models have found that even when wage decreases occurred, they were relatively minor.²³

B. Highlighting Benefits

While the purported costs of immigration on the U.S.-born workforce may be inconclusive, its benefits are clear. Immigration has positive implications for long-term economic growth, innovation, workforce development, diversity, and aggregate incomes. For instance, a 2019 study found that high-skilled immigrants have a two-fold impact on long-term growth: amplified innovation and expansions in human capital accumulation. This study also provides evidence of increased cultural diversity leading to higher economic growth due to the differences in educational institutions and culture allowing for variance in skills. In urban economies, diversity increases task specialization and social intensive skills that eventually produce a more team-oriented and interactive workforce.²⁴ Additionally, some evidence suggests that high-skilled immigration increases the incomes of low-skilled workers, including those who are native-born, thus resulting in a measurable decrease in income inequality across the labor force.²⁵

Immigration supports overall social surplus both in the short- and long-run. In studies that research these impacts, long-run impacts are operationalized as the economic impact of a single immigrant and their descendants over each's lifetime. Immigrants currently in residence yield an average of \$58,000 in aggregate income per immigrant, according to the Congressional Budget Office.²⁶ New arrivals contribute even more, supplementing the economy with some \$259,000 per immigrant. Those with just a high school diploma add \$239,000 to the economy and even those who did not graduate contribute \$35,000.²⁷ Moreover, Brookings estimates that immigrants are 30 percent more likely to engage in entrepreneurial activity than U.S.-born citizens, thereby contributing to long-term economic growth.²⁸

²³ David Card. "Immigration and Inequality." *American Economic Review* 99, no. 2 (2009): 1-21, <https://www.aeaweb.org/articles?id=10.1257%2Faeqr.99.2.1>.

²⁴ Gary C. Lin, "High-skilled Immigration and Native Task Specialization in U.S. Cities," *Regional Science and Urban Economics* 77 (2019): 289-305, <https://doi.org/10.1016/j.regsciurbeco.2019.06.004>.

²⁵ Barry R. Chiswick, "Immigration: High Skilled vs. Low Skilled Labor?" IZA Institute of Labor Economics, July 2011, <http://ftp.iza.org/pp28.pdf>.

²⁶ "How Changes in Immigration Policy Might Affect the Federal Budget," Congressional Budget Office, January 2015, <https://www.cbo.gov/publication/49868>.

²⁷ Francine D. Blau and Christopher Mackie, *The Economic and Fiscal Consequences of Immigration*. (Washington, D.C.: The National Academic Press, 2016), https://d279m997dpfwgl.cloudfront.net/wp/2016/09/0922_immigrant-economics-full-report.pdf.

²⁸ Michael Greenstone, Adam Looney, Josh Carpenter, and Sophia Campbell, "Ten Economic Facts about Immigration," Brookings, September 25, 2010, <https://www.brookings.edu/research/ten-economic-facts-about-immigration/>.

IV. Economic Linkages

A. Linking Immigration to the Technology Sector

The current technology sector is booming and, as the digital age progresses, will continue to grow substantially in the coming years. Currently, the estimated direct economic output of the tech industry is \$2 trillion, which accounts for 10.5 percent of the national economy, despite comprising only 7.9 percent of the labor force.²⁹ It can be implied, then, that the tech sector is one of the most productive sectors and has the capacity to grow exponentially should its labor force share compare with its output share.

Despite the tech industry's recent growth, many technology firms have struggled to find job candidates with the necessary skills in data science, artificial intelligence, machine learning, cloud engineering, and SQL data programming to fill open positions.³⁰ **Figure II** is a visualization of a McKinsey survey highlighting what executives and managers believe are the biggest potential skills gaps to address, indicating the percentage of businesses claiming to have a skills gap across such work areas. Of the 13 business sectors listed in **Figure II**, more than half have direct or peripheral implications for technology and innovation. Indeed, with the rise of new technologies such as AI, blockchain, and virtual reality, there is a higher demand for technologically savvy employees. However, the number of native-born workers able to take these positions is not sufficient to meet this demand.³¹ It is no surprise, then, that companies are wary of the future, as indicated by a study conducted in 2019 by Wiley Education Services and Future Workplace, which found that 64 percent of human resources leaders claim their companies have a skills gap, an increase from 52 percent in 2018.³²

²⁹ "Assessing the IT Skills Gap: IT Workforce," CompTIA, 2021, <https://www.comptia.org/content/research/assessing-the-it-skills-gap>.

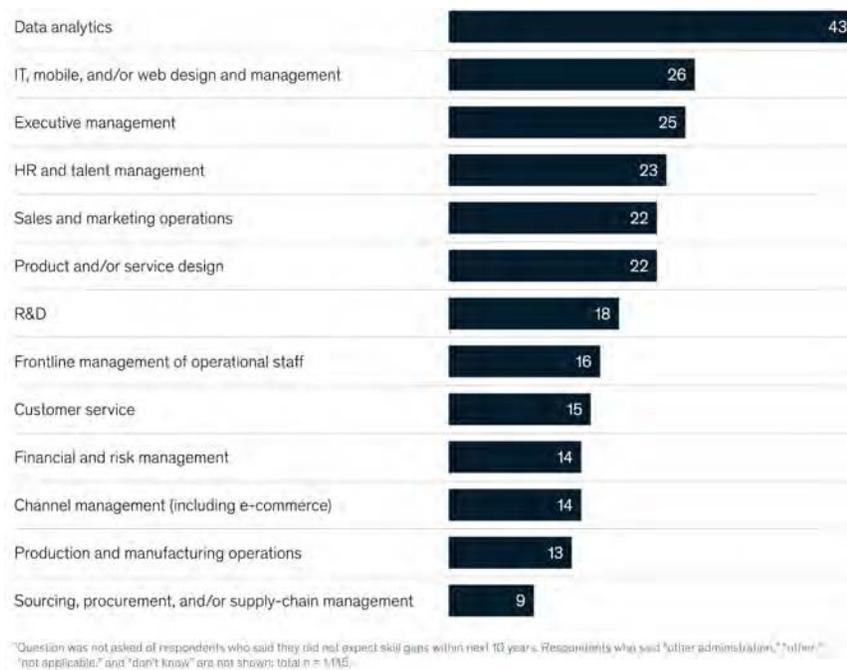
³⁰ Dom Nicastro, "Understanding the Tech Skills Gap," CMSWire, October 1, 2019, <https://www.cmswire.com/digital-workplace/understanding-the-tech-skills-gap>.

³¹ "Beyond Hiring: How Companies Are Reskilling to Address Talent Gaps," McKinsey & Company, February 12, 2020, <https://www.mckinsey.com/business-functions/organization/our-insights/beyond-hiring-how-companies-are-reskilling-to-address-talent-gaps#>.

³² Andrew J Magda, et. al., "Closing the Skills Gap 2019," Wiley Education Services and Future Workplace, September 2019, <https://edservices.wiley.com/wp-content/uploads/2020/07/201908-CSG-Report-WES-FINAL.pdf>.

Figure II

Business Areas with Greatest Need to Address Potential Skills Gaps (% of respondents)



Another 82 percent of information technology business executives are worried about the skills gaps at their firms and organizations. Such gaps lower employee productivity, reduce customer engagement, and slash sales and profitability, among other negative effects.³³ In order to mitigate and perhaps reduce the negative externalities of the skills gap, these same companies are asking universities to develop more tech-focused programs and applied curricula to help students develop skills in computer science programs.³⁴ To date, such ventures have not filled the disparity between the number of skilled workers needed and those available.

Currently, there are 12.1 million people employed in technology jobs in the United States.³⁵ Of employees working in high-tech and innovation-related industries, 24 percent of workers are immigrants.³⁶ Thus, at least 1.7 percent of the American labor force, some 2.9 million people, are high-skilled immigrant workers. In keeping with this trend, and contextualizing several studies which indicate that immigrants are more likely to work in lower-skilled occupations than native-born workers, Pew Research Center found that the proportion of immigrants working jobs

³³ "Assessing the IT Skills Gap: IT Workforce," CompTIA, 2021.

³⁴ Nicastro, "Understanding the Skills Gap."

³⁵ "2021 Tech Industry Job Market & Salary Trends Analysis," Cyberstates, CompTIA, 2021, <https://www.cyberstates.org/>.

³⁶ Dina Gerdeman, "High-Tech Immigrant Workers Don't Cost US Jobs", Harvard Business School Working Knowledge, January 2014, <https://hbswk.hbs.edu/item/high-tech-immigrant-workers-dont-cost-us-jobs>.

with higher skill requisites has increased from 20 percent in 1995 to 25 percent in 2018. This employment development is largely due to the rising level of education among immigrants. Indeed, the proportion of immigrants older than 25 with a Bachelor's degree or higher has increased from 22 percent in 1995 to 34 percent in 2018.³⁷

William Kerr, an associate professor at Harvard Business School, with Sari Kerr and William Lincoln, researched the impact of increased employment of young, skilled immigrants or foreign-born workers exclusively in high-tech firms. He came to many of the same conclusions as researchers studying general immigration effects; namely that the hiring of high-skilled immigrants and foreign nationals increased the overall employment of skilled workers in the firms.³⁸ He also found that young workers under the age of 40 accounted for the majority of the skilled immigrant labor population, comprising 90 percent of H-1B workers. Thus, immigrant employment merely lowered the average age of the workforce rather than truncating employment overall, and in fact expanded employment. Kerr's conclusions, thus, offer a tech-specific context for skilled immigration that continues to contrast narratives suggesting that immigration contracts native-born work opportunities.³⁹

The U.S. workforce as it stands currently lacks the technical knowledge and skill to fill the available high-tech positions. In fact, there are an estimated 250,000 computer science jobs available in the United States at all times, with almost five open jobs available for every software developer searching for work. Moreover, the Department of Labor predicts that there will be 1.4 million jobs open in computer specialist fields in the near future, but based on current projections, American universities only produce enough skilled degree-holders to fill 29 percent of these positions. The tech industry would benefit from employing high-skilled immigrants to fill these open jobs and increase productivity. In fact, many high-skilled immigrants who initially immigrate to the United States to work for tech companies later start their own businesses, creating more jobs in the U.S. and disputing the claim that immigrants are only taking jobs away from Americans.⁴⁰

³⁷ Jesse Bennett, "The Share of Immigrant Workers in High-Skill Jobs Is Rising in the U.S.," Pew Research Center, August 27, 2020, <https://www.pewresearch.org/fact-tank/2020/02/24/the-share-of-immigrant-workers-in-high-skill-jobs-is-rising-in-the-u-s/>.

³⁸ Sari P. Kerr, William Kerr, and William F. Lincoln, "Summary: Skilled Immigration and the Employment Structures of U.S. Firms," Harvard Business School, Nov 2013, <https://hbswk.hbs.edu/item/7388.html>.

³⁹ Sari P. Kerr, William Kerr, and William F. Lincoln, "Skilled Immigration and the Employment Structures of U.S. Firms," Harvard Business School, Nov 2013, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2354963.

⁴⁰ Salvador Rodriguez, "Why Tech Companies Need Immigrants to Function," January 30, 2017, <https://www.inc.com/salvador-rodriguez/why-tech-needs-immigrants.html>.

B. Linking Tech to the Greater Economy

Given that immigration is critical to improving American productivity and bolstering tech efficacy in the economy, it is also necessary to consider the wider implications of tech development for the economy at large. The tech sector contributes greatly to the American economy.

The National Bureau of Labor Statistics identifies the high-tech sector by using data from the Occupational Employment Statistics survey and the Current Population Survey to determine the percentage of jobs held in each industry by STEM workers. If at least 14.5 percent of workers in an industry are tech employees, then the BLS classifies the industry as high-tech. These industries are then separated into two groups: high-tech manufacturing industries (a subset of goods-producing industries) and high-tech service industries.⁴¹ Overall, BLS identifies 27 industries as high-tech (see **Figure III**).

The BLS uses the Standard Occupational Classification system to classify STEM occupations. There are two main STEM domains, each of which contains two sub-domains, according to the following criteria:

Science, Engineering, Mathematics, and Information Technology Domain

1. Life and physical sciences, engineering, mathematics, information technology occupations
2. Social science occupations

Science- and Engineering-Related Domain

1. Architecture occupations
2. Health occupations

Within each subdomain, the following types of STEM occupations are present: research occupations, development occupations, design or practitioner occupations; technologist and

⁴¹ "Options for Defining STEM (Science, Technology, Engineering, and Mathematics) Occupations under the 2018 Standard Occupational Classification (SOC) System," U.S. Bureau of Labor Statistics, June 2019, https://www.bls.gov/soc/attachment_a_stem_2018.pdf; Brian Roberts and Michael Wolf, "High-tech industries: an analysis of employment, wages, and output." U.S. Bureau of Labor Statistics, May 2018, <https://www.bls.gov/opub/btn/volume-7/high-tech-industries-an-analysis-of-employment-wages-and-output.htm>; note: "Overall, STEM occupations accounted for 6.1 percent of wage and salary jobs in 2016, however the overall rate is not reflective of the differences in STEM concentration when industries are split into goods-producing industries and service-providing industries. This analysis differs from the previous analysis by recognizing this difference and treating goods-producing and service-providing industries separately. The STEM share for all service-providing industries is 5.9 percent, but in goods-producing industries, a noticeably higher 7.4 percentage of workers was employed in STEM occupations. This analysis identifies individual goods-producing industries that had a STEM share at least 2-1/2 times the national average for all goods-producing industries (greater than 18.5 percent) and service-providing industries that had a STEM share at least 2-1/2 times the average for all service-providing industries (greater than 14.7 percent)."

technician occupations; postsecondary teaching occupations; managerial occupations; and sales occupations.

To understand the impact of the tech sector on the economy, it is also important to examine the share of employment and output accounted for by the sector. **Figure III** presents the tech sector's economic contributions in employment and production terms, highlighting the prominent role the industries in the high-tech sector play in the American economy.⁴²

Figure III

Industry title	2014 Employment (in thousands)	2014 Output (in billions)
Resin, synthetic rubber, and artificial synthetic fibers and filaments	93.1	111.6
Pharmaceutical and medicine	279.5	244.3
Industrial machinery	108.1	49.1
Commercial and service industry machinery manufacturing, including digital camera	87.5	29.9
Engine, turbine, and power transmission equipment	102.9	52.0
Other general purpose machinery	264.7	109.8
Computer and peripheral equipment manufacturing, excluding digital camera	162.8	62.6
Communications equipment	93.5	60.0
Audio and video equipment	18.9	7.0
Semiconductor and other electronic component	367.8	123.0
Navigational, measuring, electromedical, and control instruments	388.3	158.4
Manufacturing and reproducing magnetic and optical media	18.9	6.1
Electrical equipment manufacturing	143.7	39.9
Aerospace product and parts	488.4	258.0
High tech services industries		
Pipeline transportation	47	30.4
Software publishers	312.5	192.4
Wired telecommunications carriers	607	390.4
Wireless telecommunications carriers (except satellite)	155.3	245.1
Satellite, telecommunications resellers, and all other telecommunications	93.5	41.9
Data processing, hosting, and related services	279.4	133.3
Other information services	217.8	76.4
Architectural, engineering, and related services	1,380.40	322.8
Computer systems design and related services	1,777.70	351.5
Management, scientific, and technical consulting services	1,244.40	214.2
Scientific research and development services	634.7	239.6
Management of companies and enterprises	2,169.40	574.9
Other high tech industries		
Forestry	15.8	6.9
Oil and gas extraction	197.9	410.4
Electric power generation, transmission and distribution	392.1	291.3
State government education	2,409.20	147.0
Federal government	2,136	1,062.0

Source: U.S. Bureau of Labor Statistics.

In 2014, high-tech industries accounted for 16.9 million jobs in the United States, making up 12 percent of total employment. In the same year, those industries generated \$7.1 trillion of output, which was 22.8 percent of the national total. This high magnitude of production is true of all occupations within these industries, not just STEM-focused workers.⁴³

In terms of workers and wages, median wages tend to be higher in high-tech industries than those in low-tech industries, as tech salaries throughout the country are consistently higher

⁴² Michael Wolf and Dalton Terrell, "The High-Tech Industry, What Is It and Why It Matters to Our Economic Future," United States Bureau of Labor Statistics, May 2016, <https://www.bls.gov/opub/btn/volume-5/pdf/the-high-tech-industry-what-is-it-and-why-it-matters-to-our-economic-future.pdf>.

⁴³ Wolf and Terrell, "The High-Tech Industry, What Is It and Why It Matters to Our Economic Future."

than the national average.⁴⁴ Tech employs tens of millions of workers and generates trillions of dollars in output, occupying an indispensable role in the American economy. Although the extent of the skills gap threatens to undermine innovation, development, and tech expansion, reforms that facilitate the entrance of high-skilled immigrants into the workforce will help to reverse recent negative trends in productivity and technological advancement and contribute to wide economic growth.⁴⁵

V. Qualifying the Impetus for Change

A. The Extent and Severity of the Skills Gap

While some argue that high-tech firms do not have greater hiring difficulties than other establishments or deny the existence of the STEM skills gap, research shows that, in 2020, there were 3.9 million tech job openings, with a consistent average of 3 million tech vacancies since 2016.⁴⁶ Additionally, 245,500 net new tech jobs are projected to open up in 2021.⁴⁷ These gaps are likely to have far-reaching negative implications for economic growth: in the manufacturing sector alone, the skills gap, largely caused by lack of technology talent, is known to reduce labor productivity by 51 percent, innovation by 43 percent, and long-term growth by 42 percent.⁴⁸ With similar gaps in sectors throughout the economy, such reductions in technological and economic advancement are significant.

Some have voiced concerns that the skills gap is not properly defined, as there is not enough clarity on what “technical skills” actually refers to. Because the skills gap has yet to be operationalized, though, current skills gap statistics may be underestimating the extent of the labor shortage.⁴⁹ Even so, there is a range of specified industries and degree fields within the high-tech sector whose current lack of appropriately skilled employee candidates indicates that high-skilled immigration reform is necessary in order to reach potential.

⁴⁴ Connie Loizos, “A Look at Tech Salaries and how they could change as more employees go remote,” TechCrunch, June 2020, <https://techcrunch.com/2020/06/23/a-look-at-tech-salaries-and-how-they-could-change-as-more-employees-go-remote/>.

⁴⁵ Rumki Majumdar, “Understanding the Productivity Paradox,” Deloitte Insights, October 27, 2017, <https://www2.deloitte.com/us/en/insights/economy/behind-the-numbers/decoding-declining-stagnant-productivity-growth.html>.

⁴⁶ Andrew Weaver, “The Myth of the Skills Gap,” MIT Technology Review, April 2, 2020, <https://www.technologyreview.com/2017/08/25/149485/the-myth-of-the-skills-gap>

⁴⁷ Cyberstates 2021.

⁴⁸ Craig Giffi et al., “The Jobs are Here, but Where are the People?” Deloitte, November 14, 2018, <https://www2.deloitte.com/us/en/insights/industry/manufacturing/manufacturing-skills-gap-study.html>.

⁴⁹ Weaver, “The Myth of the Skills Gap.”

There also exists a preconceived notion that the skills gap could be addressed if tech companies invested more into their workforces and strategically allocated their resources.⁵⁰ While tech companies invest significantly in training employees and developing their skills, it would simply not be feasible to provide the level of education to workers necessary to sufficiently reduce the skills gap, especially with the increasing prices of a college education and the U.S.' less-than-sufficient performance in STEM curricula at the K-12 levels.⁵¹ Mitigating the existing skills gap requires a level of education comparable to a degree or vocational certificate, and it is unlikely that tech companies would ever be able to assume the role of an institution of higher learning while maintaining their other operations.

In addition, the United States is only graduating 65,000 students a year with tech-related degrees and most do not graduate with sufficient training to be employable.⁵² This factors into another widely-held notion: that the United States should simply focus on developing its STEM educational programs instead of increasing high-skilled immigration. By improving its education system, some argue, the United States can achieve the same reduction in the skills gap and help its citizens advance in the high-tech sector. This argument, however, overlooks the high costs and low feasibility of such an approach.

The timetable required to compare the effects of different educational outcome improvements and to settle on an effective national strategy is considered to be too long and could extend indefinitely, undermining the immediacy of current skills gap needs.⁵³ Education reform, thus, is critical for contracting the skills gap years in the future but does little to improve the current labor and output shortage. Even then, because education funding and achievement standards in the United States are determined at the local level, any effort at a comprehensive, efficient, and effective national push to improve STEM education would be challenging to implement and would likely be complicated by political gridlock and bureaucracy, as has been

⁵⁰ Sarah Franklin, "The Pandemic Widened The Skills Gap And The Tech Industry Must Step Up," *Forbes*, December 2, 2020, <https://www.forbes.com/sites/forbescommunicationscouncil/2020/12/03/the-pandemic-widened-the-skills-gap-and-the-tech-industry-must-step-up/?sh=273397e360e8>.

⁵¹ Govind Bhutada and Aran Ali, "The Rising Cost of College in the U.S.," Visual Capitalist, February 4, 2021, <https://www.visualcapitalist.com/rising-cost-of-college-in-u-s/>; and Drew DeSilver, "U.S. Academic Achievement Lags That of Many Other Countries," Pew Research Center, August 21, 2020, <https://www.pewresearch.org/fact-tank/2017/02/15/u-s-students-internationally-math-science/>.

⁵² Justin Vianello, "How to Address the Tech Skills Shortage with Net-New Talent," CIO, August 25, 2020, <https://www.cio.com/article/3572320/creating-net-new-tech-talent-during-the-worst-talent-shortage-we-ve-seen.html>.

⁵³ Lewis C. Solmon, "Education Policy 'Lag Time'," *Education Week*, December 10, 2003, <https://www.edweek.org/policy-politics/opinion-education-policy-lag-time/2003/12>.

exemplified by efforts in the past two decades to reform American education like the *No Child Left Behind Act*.⁵⁴

Even the swift implementation of a comprehensive strategy that substantially improves educational outcomes in STEM fields would not have effects on the workforce and economy until children and students grow up and begin working, a process that will take several years.⁵⁵ This delay, and the consequent losses in high-tech sector productivity and economic growth, are sufficient reasons to incorporate increased high-skilled immigration into strategies for reducing the immediate skills gap the economy faces. Indeed, if short-term talent shortages remain unaddressed, the long-term economic ramifications of the skills gap are destructive and may contribute to economic backsliding, reduced competitiveness, and hampered growth for years to come.

B. The Necessity of Immigration Expansion

As it stands, existing U.S. immigration policy may stymie efforts to mitigate the skills gap. For instance, some U.S. initiatives and departments, like those focused on national security, currently limit job accessibility to U.S. citizens and exclude prospective foreign workers. This practice detrimentally impacts America's labor pipeline by failing to consider the opportunity for talent acquisition by employing skilled immigrants in the United States, especially when adequate vetting and a streamlined system for skilled immigration – particularly the availability and efficiency of temporary H-1B visas and permanent E1/E2/E3 employment-based visas – can facilitate this without compromising national safety.⁵⁶

Additionally, regardless of the present skills gap, workforce diversity, in general, is a positive addition to firms' productivity. Indeed, due to the variety of backgrounds and perspectives, it contributes to knowledge creation and leads to the formation of teams that are comprised of more effective problem solvers and idea generators. Similarly, studies have found positive links between the presence of skilled migrants and innovation.⁵⁷ This is corroborated by the fact that immigrants are typically just as educated as native-born workers, with 30 percent of immigrants

⁵⁴ Camille R. Whitney, Christopher A. Candelaria, and Joseph A. Taylor, "The Effects of No Child Left Behind on Children's Socioemotional Outcomes," *AERA Open* 3, 3 (2017), <https://journals.sagepub.com/doi/full/10.1177/2332858417726324>.

⁵⁵ Solmon, "Education Policy 'Lag Time'."

⁵⁶ Lilah Burke, "Federal Report Says U.S. Needs More Technical Workers, Not Necessarily with Bachelor's Degrees," *Inside HigherEd*, September 10, 2019, <https://www.insidehighered.com/news/2019/09/10/federal-report-says-us-needs-more-technical-workers-not-necessarily-bachelors>.

⁵⁷ Max Nathan, "The Wider Economic Impacts of High-Skilled Migrants: a Survey of the Literature for Receiving Countries," *IZA Journal of Development and Migration* 3,4 (2014), <https://doi.org/10.1186/2193-9039-3-4>.

holding advanced collegiate degrees, compared to 31 percent of those born in the U.S.⁵⁸ Of all Bachelor's degree holders in STEM occupations, 25 percent were foreign-born. They also hold just under 50 percent of all PhDs in STEM occupations.⁵⁹

Calculations show that immigrants have contributed to two-thirds of STEM occupation growth since 1995.⁶⁰ Studies have also shown that cities with more immigrants who have H-1B visas have productivity levels above the national average, and native-born workers are not forced out of their jobs by these immigrants.⁶¹ H-1B visas are, therefore, positive sources of skilled labor with the capacity to mitigate the U.S.' skills gap. However, the system's convoluted nature has called its credibility into question among detractors. H-1B access for foreign skilled workers was heavily truncated in 2018 due to concerns regarding funding leakage and excessive reliance on outsourcing firms that profit at the expense of companies employing foreign workers, among other issues.⁶² That said, stagnating or ignoring the H-1B system may not be an option as demand for skilled workers continues to rise. Indeed, even now, 33 percent of HR professionals who use work visas report that "more are needed to recruit, hire, and retain employees."⁶³ Therefore, in order to capitalize on the many benefits to the economy from high-skilled immigration and the expansion of H-1B visa availability, it is imperative that actionable and urgent steps be taken to reform the system to reduce complications, bureaucracy, capital outflows, and increase American productivity.

The technical skills gap is an important crisis in the American labor markets and needs to be addressed, specifically through high-skilled immigration reform. Hiring high-skilled immigrants in the technology sector is a proven benefit to American firms and the economy at large, yet the existing procedures and structures in place that dictate immigration levels may discourage the nation from tapping into such necessary resources. Therefore, immigration reform is important to consider in continuing to address the technical skills gap that plagues American tech companies.

⁵⁸ Jens Manuel Krogstad and Jynnah Radford, "Education Levels of U.S. Immigrants Are on the Rise," Pew Research Center, July 31, 2020, <https://www.pewresearch.org/fact-tank/2018/09/14/education-levels-of-u-s-immigrants-are-on-the-rise/>.

⁵⁹ Gail Cohen, Aqila Coulthurst, and Joe Alper, *Immigration Policy and the Search for Skilled Workers: Summary of a Workshop*, (Washington, D.C.: The National Academies Press, 2015), <https://doi.org/10.17226/20145>.

⁶⁰ William R. Kerr and Sari Pekkala Kerr. "Immigrant Entrepreneurship." *Studies in Income and Wealth* (NBER), Chicago: University of Chicago Press, 2017, <https://www.nber.org/system/files/chapters/c13502/c13502.pdf>.

⁶¹ Kerr William R., and Sari Pekkala Kerr, "Immigrant Entrepreneurship," 2017.

⁶² Sara Ashley O'Brien, "Trump Administration cracks down H-1B Visa abuse," CNN Business, February 23, 2018, <https://money.cnn.com/2018/02/23/technology/h1b-visa-abuse/index.html>.

⁶³ "The Skills Gap: 2019," Society for Human Resource Management (SHRM), 2019, <https://www.shrm.org/hr-today/trends-and-forecasting/research-and-surveys/pages/skills-gap-2019.aspx>.

VI. Multilateral Government Coalitions

A. A Bipartisan Approach

Immigration reform is crucial to America's greater economy, especially as it pertains to the technology sector, an industry that employs a vast plurality of high-skilled immigrants. However, H-1B visa guidelines have not changed in 14 years, despite an exponential increase in the size and scope of the tech industry. Given that the tech sector is a significant and growing contributor to GDP and continues to employ more and more people, it is particularly concerning that reforms to the immigration system aimed at actualizing goals of American economic growth have not been made.

High-skilled immigrant labor helps allay many of the concerns regarding the skills gap in the U.S. economy, and it does so without taking away jobs from American workers. Expanding immigration admission serves to bolster the economy and create additional professional opportunities for Americans through increased spending power and immigrant entrepreneurship. It also greatly expands the tax base: immigrants contributed over \$400 billion to the American tax system in 2017.⁶⁴

These benefits have been recognized by Congress, and past legislative action has indicated broad bipartisan support for increased high-skilled immigration into the United States. H.R. 1044, the *Fairness for High-Skilled Immigrants Act of 2020*, passed in both the House and the Senate with overwhelming support from both sides of the aisle. The bill aimed to increase the per-country cap for family-based immigrant visas and eliminate the per-country cap on employment-based visas, but it ultimately failed as there were issues with reconciling multiple versions of the bill. President Biden's *U.S. Citizenship Act of 2021* includes similar provisions in the larger bill. While the entirety of his immigration agenda may lack bipartisan appeal, eliminating the cap on employment-based visas remains a realistic, important goal and represents a starting point from which bipartisan efforts can work to encourage increased high-skilled immigration.

B. A Federal Directive

The U.S. government stands to benefit economically, technologically, and competitively if it favors and streamlines high-skilled immigration, which is linked to greater economic prosperity due to its ability to expand the tax base as well as create more jobs for Americans. As elucidated in this report, immigrants serve as a valuable source of American entrepreneurship, creating many jobs for Americans in the process.

⁶⁴ Zachary Mueller, "Immigration 101: Do Immigrants Pay Taxes?" *America's Voice*, May 23, 2019, <https://americasvoice.org/blog/immigration-101-immigrant-taxes/>.

Additionally, high-skilled immigration can be a strong boost to technological innovation. The vast majority of high-skilled immigrants are proficient in STEM fields, and considering the existing STEM skills gap in the American labor force, private sector industries seeking to innovate technologically would benefit from a greater supply of skilled workers and the inclusion of skilled immigrants in the labor force. The potential gains in technological abilities would be to the benefit of the nation at large, as higher levels of development correlate with higher standards of living.

Finally, broader immigration reform can help solidify America's global competitive edge in an era when countries like China and Russia threaten American economic dominance. Allowing some of the brightest and most talented individuals to immigrate from competing countries to the United States could be a net gain for America's position in the global economy. Moreover, increasing the quantity of high-skilled immigrants could signal and facilitate a shift towards American emphasis on STEM education. Consequently, the United States could be positioned to function as a more tech-centered and innovative nation in the years to come.

C. A State-led Initiative

High-skilled immigration certainly has national appeal, but each state varies in its economic composition and technological development, and thus will experience varied effects once improvements to the high-skilled immigration system are enacted. For the more rural states with economies that are less reliant on the technological sector, many of the few technology companies within those states rely on high-skilled immigration to provide them with much-needed workers. Encouraging high-skilled immigration would help these states continue to build up their technological economies, facilitate growth in prominent non-tech industries, and contribute to overall increases in productivity.⁶⁵ The strong expansion of rural states' technology sectors will help diversify the economy, increasing job opportunities for the next generation.

For more technologically developed state economies, existing tech companies will help attract many of the high-skilled workers that immigrate to the United States. In addition, high-skilled immigrants provide much-needed consumption spending, investment, and state taxes to individual states, helping to grow state economies and finance state expenditures.

To better analyze the situation in all 50 states, individual state reports have been prepared that cover the potential benefits of immigration reform in more detail. Each report seeks to provide a concise summary of the impact of the technology sector and the economic contributions of high-skilled immigrants in a given state.

⁶⁵ Zia Qureshi, "Technology and the Future of Growth: Challenges of Change," Brookings, February 27, 2020, <https://www.brookings.edu/blog/up-front/2020/02/25/technology-and-the-future-of-growth-challenges-of-change/>.

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